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Decisions Made During Program Execution as a Root Cause of Nunn-McCurdy Breaches

**The Evidence from Root Cause Analyses done by
RAND and IDA for PARCA**

May 16-17

David L. McNicol

IDA | Background: Nunn-McCurdy Act and the Weapon Systems Acquisition Reform Act

- The topic of this brief cannot be stated clearly without first noting aspects of the Nunn-McCurdy Act (1983) and the Weapon Systems Acquisition Reform Act (WSARA—2009).
- The Nunn-McCurdy Act establishes limits on cost growth, which, if exceeded, require the Secretary of Defense to at least notify the Congress and—if the growth exceeds a “critical” limit—to recertify the program.
- The Nunn-McCurdy Act defines two measures of cost growth:
 - Program Acquisition Unit Cost (PAUC): the per unit produced cost of developing and procuring the program.
 - Average Procurement Unit Cost (APUC): the program’s procurement cost per unit produced.
- The Nunn-McCurdy Act requires measuring cost growth against each of two not necessarily distinct baselines:
 - The original baseline, usually that established at Milestone B; and
 - The current baseline, if the program has been rebaselined.

IDA | Nunn-McCurdy Act Thresholds

	Original Baseline	Current Baseline
PAUC		
Significant	$\geq 30\%$	$\geq 15\%$
Critical	$\geq 50\%$	$\geq 25\%$
APUC		
Significant	$\geq 30\%$	$\geq 15\%$
Critical	$\geq 50\%$	$\geq 25\%$

IDA | WSARA (2009)

- WSARA, among several other things:
 - Establishes the Office of Performance Assessments and Root Cause Analyses (PARCA);
 - Requires the Director of PARCA to perform a “root cause analysis” (RCA) of all major acquisition programs that experience a critical Nunn-McCurdy breach.
- WSARA also lists eight “root causes” for use in the required root cause analyses; in abbreviated form these are:
 1. Unrealistic performance expectations
 2. Unrealistic baseline estimates for cost and schedule
 3. Immature technologies or excessive manufacturing or integration risk
 4. Unanticipated design, engineering, manufacturing, or technology integration issues arising during program performance
 5. Changes in procurement quantities
 6. Inadequate program funding or funding instability
 7. Poor performance by government or contractor personnel responsible for program management
 8. Other

IDA | Key Elements of PARCA Guidance for RCAs

- PARCA has informally specified a top level taxonomy of cost growth for use in RCAs:
 - **Inception:** Sources of cost growth inherent in the relevant Acquisition Program Baseline (APB).
 - **Execution:** Cost growth that results from decisions made post-APB.
 - **Endogenous:** Although the proximate cause of the growth is a decision made after the APB is issued (e.g., a program stretch), the decision is driven by some flawed aspect of the APB (e.g., an unrealistic procurement cost estimate).
 - **Exogenous:** A decision is made for reasons largely or entirely unrelated to problems with the program.
- PARCA's informal guidance to analysts also distinguishes:
 - **Proximate causes** of cost growth—aka the “accident scene investigation”; and
 - The analysis connecting specific proximate causes to **root causes**.

- Remote Minehunting System
- Global Hawk
- ChemDemil ACWA
- F-35
- Summary of IDA Conclusions

Remote Minehunting System (RMS)

Bailey, John W., Alexander O. Gallo, Tzee-Nan Lo, Caolionn L. O'Connell, Thomas P. Frazier (Project Leader), and Patricia F. Bronson (Task Leader). "Remote Minehunting System: Root Cause Analysis." IDA Paper P-4600. Alexandria, VA: Institute for Defense Analyses, June 2010.

IDA | RMS 1: Introduction

- RMS was initially an Acquisition Category (ACAT) II program. In 1999, it was granted authority to begin Engineering and Manufacturing Development (EMD).
- RMS received authority to enter full rate production in 2005.
- By the following year, RMS funding had increased to the point that it was designated an ACAT IC program—that is, a Major Defense Acquisition Program for which the Service Acquisition Executive is the Milestone Decision Authority.
- In June of 2007, RMS was decertified for Operational Test.
- The Congress was notified of critical Nunn-McCurdy breaches for both RMS's PAUC and APUC in Dec. 2009.

IDA | RMS 2: Proximate Causes of Growth in RMS PAUC over the 2006 Acquisition Program Baseline*

Inception	%
Unrealistic unit cost estimation	14
Execution	
Endogenous to RMS	
- Reliability Growth Program	18
- Five year production Gap	4
- Reduced Production Rate	8
Exogenous—Quantity reduction	35
Not Classified	6
Total	85

②

③

④

①

Next chart

*The PARCA categories had not been fully developed when the IDA study was done and the results were presented in slightly different categories.

IDA | RMS 3: Comments on the Proximate Causes

- 1 (35%) The planned procurement quantity was reduced by just over 50% because the Navy decided to use a more advanced system for the anti-submarine warfare mission module of the Littoral Combat Ship (LCS). The IDA study found that reliability issues were not among the factors behind this decision.
- 2 (14%) The 2006 APB did not use the then available data on two prior production lots.
- 3 (22%) Reliability issues (described on the next chart) led to a five-year gap in production and the adoption of a reliability growth program.
- 4 (8%) The Navy decided to stretch the (reduced) planned production. The decision to reduce the planned buy did not force this decision, so it is scored here as an Endogenous Execution decision, reflecting cost growth.

IDA | RMS 4: Reliability Issues and Government Oversight

- IDA identifies “three significant ways” in which the “Navy failed to follow appropriate acquisition policies and procedures” (Bailey *et al* p. 9)
 1. “inadequate contract planning, due to schedule pressures and personnel shortages”
 2. Award of the first Low Rate Initial Production (LRIP) contract “based on build to print terms...without adequately reviewing the contractor drawings”
 3. “the immature design resulted in early development and production units falling short of the system’s performance thresholds for availability and reliability during testing.”
- The study directly connects the third of these (but not the first two) to cost growth; in particular, the costs of the five-year production slip and the reliability growth program.
- The pivotal fact noted by the study in this connection is that the first three LRIP lots were put on contract even after testing had revealed reliability issues and reliability improvement on continuing testing was “marginal at best.”

IDA | RMS 5: RMS PAUC Growth in WSARA Root Cause Categories

#2	Unrealistic baseline estimate for cost or schedule.	14%
#7	Poor performance by government or contractor personnel responsible for program management	22%
#5	Endogenous stretch in (reduced) planned procurement	8%
#5	Exogenous changes in total procurement quantities	35%
	Not tracked to a WSARA root cause	6%
	Total change from Acquisition Program Baseline	85%

“The analysis also examined the root causes behind the three proximate causes. Two root causes are directly related to their proximate causes (procurement reduction and a baseline cost error). The decision to reduce the procurement quantities appears to be exogenous to the program and unrelated to reliability issues. The baseline cost estimate was unrealistic, since the original estimates did not include some cost data. The final root cause—failure of government oversight—manifested itself in the reliability issues.” Bailey *et al.*, S-1 and S-2.

Global Hawk

Fox, Jeffrey N., Paul M. Kodzwa, David M. Tate (Project Leader), and Patricia F. Bronson (Task Leader). "Global Hawk: Root Cause Analysis of Projected Unit Cost Growth." IDA Paper P-4668. Alexandria, VA: Institute for Defense Analyses, May 2011.

IDA | Global Hawk 1: Introduction

- Global Hawk began in 1995 as an Advanced Concepts Technical Demonstration project of the Defense Advanced Research Projects Agency.
- In 2001, Global Hawk was designated as an MDAP and authorized to begin EMD and Low Rate Initial Production (LRIP).
- Global Hawk experienced significant Nunn-McCurdy breaches in 2004 and 2005 and critical breaches for both PAUC and APUC in 2006.
- A CAPE-CA fast turnaround estimate in 2010 indicated that Global Hawk costs had increased to near the level of critical breach.
- PARCA was tasked by the USD(AT&L) to undertake an RCA in anticipation of the declaration of a Nunn-McCurdy breach, and PARCA tasked the supporting IDA analysis.
- A critical Nunn-McCurdy breach was declared in April 2011. The program was certified by USD(AT&L) in June 2011.
- One main variant of Global Hawk (the Block 30) was cancelled in the President's Budget submitted to the Congress in January 2012.

IDA | Global Hawk 2: Proximate Causes of Growth of APUC from the 2007 Baseline

Inception	%	
Increased cost for content included in the 2007 Baseline	14.1	} 21.5
Stretch of test schedule*	7.4	
Execution—Exogenous		
Changes in the mix of aircraft purchased	6.7	} 13.9
More initial spares because of increased aircraft utilization	7.2	
Other—Not Classified		
Engineering Change Orders above contractor historical average	2.0	} 11.7
Known program content not included in 2007 cost estimate	9.7	
Total	47.1	

What is the appropriate classification for known content not included in the baseline cost estimate?

IDA | Global Hawk 3: Evolutionary Acquisition and Uncosted Content in the 2007 Baseline

- Global Hawk was directed to pursue an evolutionary acquisition strategy when, in 2001, it was designated an MDAP.
- In 2002, the program office and the contractor established six spirals, each to carry a common sensor/SIGINT package.
- Under the rules then prevailing:
 - Requirements for each spiral were to be fully specified and costed, but
 - The question of what requirements were to eventually be met (by as-yet-unspecified spirals) could be left open and, hence, not costed.
- By 2006, the program had become a concurrent development of four distinct platform/sensor variants (Blocks 10, 20, 30, & 40).
- Under the 2006 revision of the Capabilities Development Document (CDD), the four variants would provide all of the capabilities required.
- The 2006 CDD stated future dates by which various capabilities were to be provided. The costing of the 2007 APB excluded some known requirements for one or more of the variants.

The uncosted content appears to be a legacy of Global Hawk's origin as an evolutionary acquisition.

IDA | Global Hawk 4: APUC Growth from 2007 Baseline in WSARA Root Cause Categories

#2	Unrealistic 2007 baseline estimate for cost or schedule	21.5%
#5	Exogenous: Changes in mix	6.7%
#8	Exogenous: Other—increased aircraft utilization requires more initial spares	7.2%
#7	Poor performance by government or contractor personnel responsible for program management	9.7%
	Not tracked to a WSARA root cause category	2.0%
	Total APUC change from 2007 Baseline	47.1%

- The two exogenous execution changes would have pushed the program into a critical breach, but these are indications of program success, not failure.
- The known content not included in the cost estimate of the revised (2007) baseline is not cost growth, as it represents costs of capabilities specified in the 2006 CDD.
- To this extent, the Global Hawk's 2011 critical Nunn-McCurdy breach is a self-inflicted wound.

Chemical Demilitarization—Assembled Chemical Weapons Alternatives (ACWA)

O’Connell, Caolionn L. (Project Leader), Ji S. Byun, and Patricia Bronson (Task Leader). “Chemical Demilitarization—Assembled Chemical Weapons Alternatives (ACWA) Root Cause Analysis.” IDA Paper P-4677. Alexandria, VA: Institute for Defense Analyses, July 2011.

IDA | ChemDemil ACWA 1: Introduction

- ChemDemil ACWA began in 1996. It was designated an MDAP in 2003, and an APB for the program was established at that time.
- ACWA experienced a critical Nunn-McCurdy breach in 2006. A new APB for the program was established in April 2007.
- The Congress was notified of a second critical Nunn-McCurdy breach for ACWA in December 2010.
- The IDA RCA examines the growth in ACWA cost from the 2007 revision of the APB to the 2011 Program Office Estimate.

IDA | ACWA 2: Proximate Causes of PAUC Growth from the 2007 APB to the 2011 Program Office Estimate (percent)*

Inception	%	
Increased construction costs	18.0	} 21.9 ①
Increased closure costs	3.9	
Execution		
Exogenous: More realistic estimate of the labor required for 24/7 systematization and operations	3.1	} 10.2 ②
Exogenous: Increased use of Explosive Destruction Technology (EDT)	5.0	
At least partly exogenous: Other scope and content changes	2.1	
Not Classified		
Larger allowance for risk	4.7	} 9.5 ③
Other—residual	4.8	
Total	41.6	

IDA | ACWA 3: Comments on the Causes of PAUC Growth

- 1 Information available and context indicate that these two items are increases in the estimated cost of content in the 2007 APB. Two qualifications are required:
 - Some of the increases may be for content beyond that in the 2007 baseline, and
 - These increases may have been inflated by a combination of schedule pressures and the contract structure.
- 2 The first two of these items (24/7 staffing and EDT) were directed changes in the program, apparently prompted by concerns with meeting U.S. treaty commitments. The “Other scope and content changes” were at least partially also exogenous.
- 3 The IDA report shows that the contract structure did not incentivize either the government or the contractors to control and realistically estimate and report life cycle costs. The treaty-driven purpose of the program and its connections to domestic concerns also gave ACWA a degree of insulation from budgetary pressures. IDA was not able to estimate the magnitude of this effect, however.

IDA | ACWA 4: IDA Assignment of Causes of PAUC Growth to WSARA Root Cause Categories

#2	Unrealistic baseline estimate for cost or schedule	22% +
#8	Exogenous changes in program content	10% -
	Poorly structured incentives on life cycle cost control and reporting	?
	Not tracked to a WSARA Category	9.5%
	Total change from 2007 Baseline	41.6%*

* Excludes growth in MILCON.

“IDA’s analysis causes traced this cost growth to three root causes—unrealistic [baseline] cost estimate, contract structure, and a larger allowance for risk. The risk categorization contains elements of both the unrealistic cost estimate and the contract structure. Due to the interconnectedness of the major causes for cost growth, the cost growth cannot be easily apportioned into the three categories.”
O’Connell et al., 21.

F-35

Arnold, Scot, Ji S. Byun, Harley Cloud, Alexander O. Gallo, Matthew W. Gonwa, Bruce R. Harmon, Prashant R. Patel, Colin D. Sullivan, John Hiller (Project Leader), and Patricia Bronson (Task Leader). “WSARA 2009: Joint Strike Fighter Root Causes Analysis.” IDA Paper P-4612. Alexandria, VA: Institute for Defense Analyses, June 2010.

IDA | F-35 1: Introduction

- A critical Nunn-McCurdy breach was declared in FY09 for the F-35. PAUC was then 57% above the original baseline.
- RAND and IDA both did an RCA of the F-35.
- Should this review attempt a synthesis of the two studies?
 - The studies take complementary approaches;
 - They both make several of the same points;
 - The two studies appear to share an underlying conception of the problems.
- An attempt at a synthesis would not be constructive in this context, however, because neither study provides an estimate of the cost growth caused by post-MS B decisions.

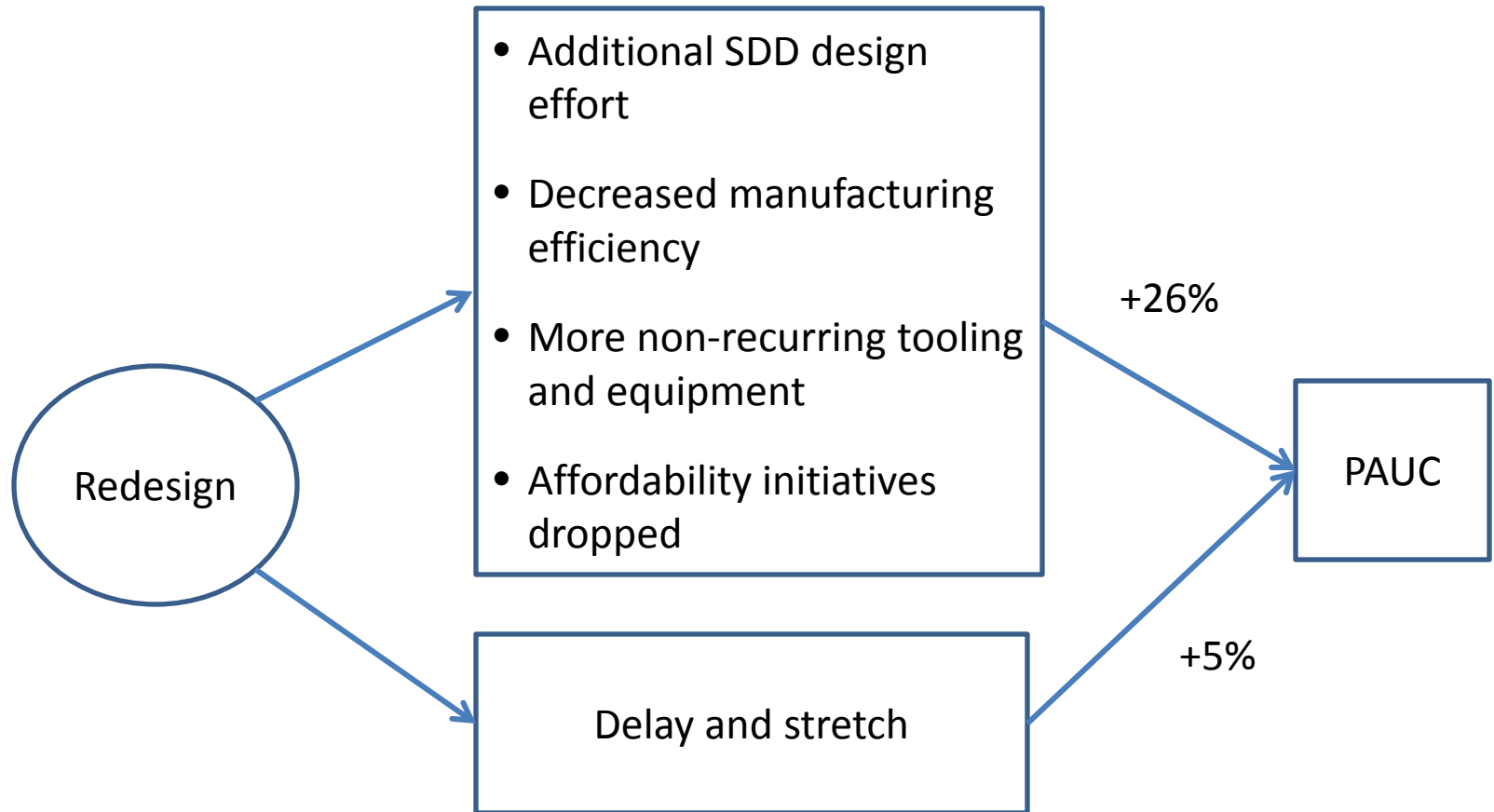
What kept these studies from identification and quantitative assessments of the major Execution Phase root causes?

IDA | F-35 2: Proximate Causes of PAUC Growth Relative to the MS B Baseline

Inception	%
MS B Weight estimate too low	6
Use of inappropriate escalation rates at MS B	14
Execution	
Endogenous: Ramp delays to peak production	2
Endogenous: Lower procurement rate and reduced quantity	3
Exogenous: Change in fee arrangements below the prime level	3
Not Classified	
Cost of Redesign	26
Residual	3
Total	57

The redesign (in the context of the F-35's technical and programmatic complexities) clearly is of pivotal importance to any root cause analysis of the program.

IDA | F-35 3: IDA's Estimate of the Contribution of the Redesign to PAUC Growth



The redesign (including the procurement stretch and delay) accounted for 31 percentage points of the 57% PAUC growth that triggered the FY09 Nunn-McCurdy Breach.

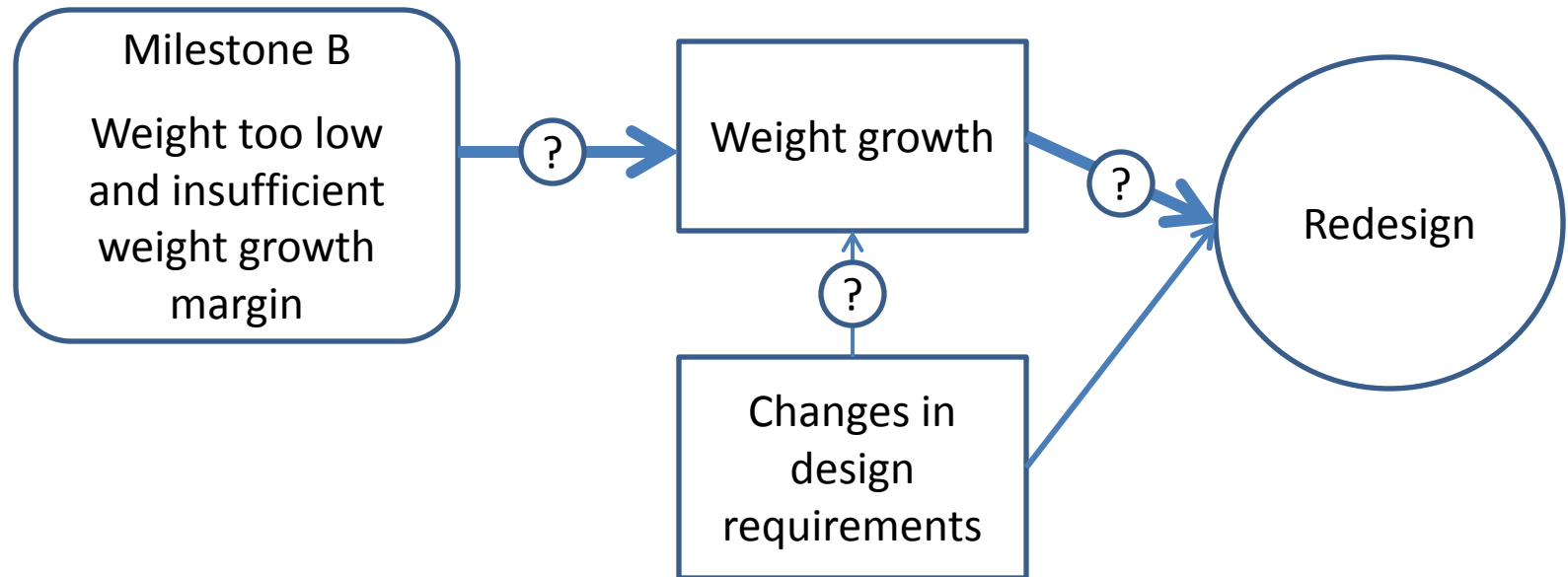
IDA | F-35 4: APUC Growth from 2007 Baseline in WSARA Root Cause Categories

#2	Unrealistic baseline estimate (weight, escalation rates)	20%
#5	Endogenous: Changes in ramp rates, buy profiles, and quantity induced by EMD cost growth and schedule slips	5%
#8	Exogenous: Changes in program content	3%*
#8	Cost of the redesign	26%
#8	Residual	3%
	Total change from 2007 Baseline	57%

Both studies recognized the importance of the redesign effort. IDA presented an estimate of the costs of the redesign, but was unable to make a clear assignment of responsibility (in terms of WSARA root causes) for these costs. The RAND study also acknowledged its inability to make firm assignments of root causes.

* The IDA analysis classifies this as an unrealistic aspect of the baseline cost estimate rather than the cost associated with a later decision.

IDA | F-35 5: Causes of the Redesign



It is arguable that the roots of the problem lie in a misperception of the maturity of the program at MS B and the great difficulties of coping with the inevitable prospect of weight growth in the context of a program to design three aircraft variants (one STOVL) with highly common airframes. It also is necessary to consider the efficiency of the contractor and the role of government-directed changes in design requirements.

IDA | F-35 6: Contractor Influences on the Redesign

RAND Study (examples)

- “By focusing on the less complex CTOL system before the more complicated difficult STOVL one, Lockheed Martin...” (51)
- “Lockheed Martin made a substantial number of important design decisions....on their own with only informal government participation and no contractual record.” (59)

IDA Study

- IDA cites other studies that found “poor performance by government or contractor personnel responsible for program management”; e.g.:
 - Mission integration and software development not under control,
 - Risk reduction management process and funding not creditable, and
 - Parts shortage and production line workarounds.

Neither study tackles the question of the extent to which Lockheed Martin decisions contributed to cost growth.

IDA | F-35 6: Conclusions

- RAND study concludes that “The root cause lies in some measure in an overly optimistic baseline estimate of the influence of acquisition reform and produceability estimates.”
- IDA concludes that: “It is clear that, at the most fundamental level, Government actions were significantly more important in driving the cost growth than contractor execution problems.”
- These conclusions are not squarely contradictory. They are different, and neither study provides a clear and compelling account of the causes of the redesign, which is the largest proximate cause of cost growth in the F-35 program.

IDA Summary of Conclusions

IDA | Summary of Conclusions

The **very** short stories of the conclusions reached on the issues considered here are:

- **DDG-1000**—PAUC breach largely driven by exogenous decrease in planned procurement.
- **RMS**—Just over 40% of the APUC growth attributable to government failure to respond appropriately to tests results on the system's reliability.
- **Global Hawk**: About one-quarter of the APUC was a self-inflicted wound: a failure to include known content in the cost estimate for 2007 rebaselined program.
- **ACWA**: One root cause is a contract structure that did not incentivize either the government or the contractor to realistically estimate and control life-cycle costs. The magnitude of cost growth attributable to this root cause was not established.
- **F-35**: Nearly half of the APUC growth is attributable to the redesign, but the root causes of the redesign were not clearly established.

IDA | Top Level View of Proximate Causes and Issues

		Inception	Execution- Endogenous	Execution- Exogenous	Not Classified	Total
RMS	PAUC	14%	22%	35%	6%	85%
Approval of three LRIP lots in the face of test results showing reliability problems.						
Global Hawk	APUC	21.5%	0	13.9%	11.7%	47.1%
In an evolutionary acquisition, content needed to meet requirements was not included in the baseline cost estimate.						
ACWA	PAUC	21.9%	10.2%	0	9.5%	41.6%
Incentive effects of contract terms and structure.						
F-35	PAUC	20%	5%	3%	29%	57%
Causes of the redesign.						

Only the one issue for each MDAP as summarized above is discussed in this brief.